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Changes in children's beliefs about everyday reasoning: Evidence from Greek primary students¹

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ABSTRACT

The study aimed at providing evidence for the development of children's beliefs about everyday reasoning. A total of 116 third, fifth, and seventh graders participated in the study. They were examined individually with 14 everyday thinking scenarios which have been developed by Amsterlaw (2006). After each scenario, children were asked to evaluate the quality of each way of thinking and to explain their evaluations. The results showed that children as young as 8-9 years have a well-developed awareness of good and bad thinking processes in everyday situations. Further, they indicate an emergent ability in fifth graders to give process-focused explanations.

Key words: Beliefs about reasoning, Development, Everyday Reasoning, Thinking.

INTRODUCTION

Thinking is a high-level, complex cognitive function which involves reasoning, problem solving, and decision making processes. Reasoning is a core element of our everyday cognition since it enables us to evaluate arguments, test alternative hypotheses, collect evidence, draw inferences, and, in the end, make decisions for our lives. While there is abundant research evidence as regards the growing understanding of formal rules of reasoning and the development of reasoning skills in children (e.g., Daniel & Klaczynski, 2006; Galotti, Komatsu, & Voelz, 1997; Handley, Capon, Beveridge, Dennis, & Evans, 2004; Morris, 2000; Morris & Sloutsky, 2002; Moshman & Franks, 1986), the development of children's beliefs about the quality of everyday thinking as a reasoning process has attracted relatively little interest (e.g., Amsterlaw, 2006; Perkins, Tishman, Richart, Donis, & Andrade, 2000). Such beliefs are part of children's metacognitive knowledge about thinking as a mental function (see Flavell, 1979).

In the research tradition of metacognition, there is abundant evidence for children's metacognitive development as regards their memory (e.g., Fabricius & Schwanenflugel, 1994) as well as various mental functions, that is, beliefs and intentions, mainly from the theory of mind perspective (e.g., Schwanenflugel, Henderson, & Fabricius, 1998). Evidence on thinking, however, is sparse and this lack has been stressed already (see Flavell, Green, & Flavell, 1995).

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Research on the developmental pattern of metacognitive knowledge about thinking as a reasoning process could contribute not only to our understanding of the construction of the *theory of mind* but also to the development of children's formal reasoning skills. It is worth mentioning that current theoretical approaches emphasize the organizing role of metacognitive processes on the development of reasoning (Kuhn, 2000; Kuhn, Katz, & Dean, 2004; Moshman, 2004). Awareness that some inferences are more certain or justifiable than others emerges around the age of 6 (see Pillow, 2002). Even though young children exhibit some understanding of the logical necessity, age-related constraints restrict this understanding (Klahr & Chen, 2003). Children up to the age of 10 lack an explicit awareness of the logical form of the inferences and thus tend to evaluate inferences based on the empirical content of their premises and the conclusion (see Moshman & Franks, 1986). According to Moshman (2004), "... what develops beyond early childhood is not the basic ability to make logical inferences, but metacognitive knowledge about the nature and justifiability of logical inferences, and metacognitive awareness, knowledge, and control of one's inferential processes" (p. 222-223).

The development of beliefs and justifications about everyday reasoning

Research on beliefs and justifications about everyday reasoning is limited. Perkins, Tishman, Richart, Donis, and Andrade (2000) showed that even 6th grade children, that is, 11-12 years old had great difficulty in detecting flaws in thinking in everyday thinking scenarios. Amsterlaw (2006) examined first, third, and fifth graders' (as well as adults') beliefs about good and bad reasoning processes in everyday thinking scenarios. In study 1 she found a developmental pattern suggesting qualitative changes in children's understanding of the distinction between reasoned and non-reasoned processes. Children as young as 6-7 years old recognized that reasoning requires effortful thinking and a length of time as compared to non-reasoned processes like using a random trial-and-error strategy to solve a problem. They considered the appropriate and smart response to a problem as a primary indication of the presence of effortful, reasoned thinking (see also Heyman, Gee, & Giles, 2003).

In Amsterlaw's study 2 the participants were presented with various scenarios describing good and bad reasoning processes in everyday situations, such as deciding to buy a camera either by using an "eenie-meenie" strategy (bad version) or by writing a list with all the things one wants to have with one's camera (good version). There were four different types of scenarios that tapped thinking as a process of: (a) strategy selection in making a choice; (b) considering alternative options of an event; (c) making a decision by considering the pros and the cons; and (d) collecting evidence in order to come to a conclusion about the cause of an event. Moreover, the participants were assigned randomly in two conditions, *no outcome* and a *mismatch*. In the *no outcome condition* there was no information given to the participants about the outcome of the reasoning process. In the *mismatch condition*, at the end of each scenario, information was added about the outcome of the specific reasoning process but the outcome was in opposition with the reasoning process. For example, a good thinking process, such as making a list in order to buy a camera, was followed by information that the child didn't like the camera she obtained.

Amsterlaw's findings suggested two developmental changes: an improvement in discriminating processes as good or bad by third grade; and an emergence of an *adult-like process focused evaluation* of the quality of thinking by fifth grade. That is, there was an evaluation that considered the involvement of thinking processes instead of judging the quality of thinking only by the outcome (that is, good thinking is the thinking which is followed by a good outcome and vice versa).

The present study

The present study is an attempt to provide evidence regarding the development of beliefs about thinking processes in everyday situations by using the same methodology in a sample of children from Greece. Evidence for the development of metacognitive knowledge about thinking as a process is sparse and there is a need for comparative evidence from a different culture to clarify the systematic nature of Amsterlaw's findings and to show possible effects

of culture-dependent socialization practices on the developmental pattern. Moreover, in order to extent Amsterlaw's evidence, a sample of seventh graders participated in the present study, along with third and fifth graders. The intention was to involve participants around the age of twelve years because is a critical point for the development of metalogical competence.

Young adolescents at this age were found to be able to decontextualize, that is, to distinguish explicitly between logical and non logical forms of arguments irrespective of their content (Efklides, Demetriou, & Metallidou, 1994; Franks, 1997; Galloti & Komatsu, 1989; Morris, 2000; Moshman & Franks, 1986).

Following Amsterlaw's evidence, the younger participants (third graders) are expected to exhibit a well-developed ability to make distinctions between good and bad thinking processes in various everyday reasoning scenarios (Hypothesis 1). Also, a second developmental change is predicted at fifth grade as regards participants' ability to evaluate the quality of the thinking processes involved in everyday scenarios (Hypothesis 2). Specifically, from this age, students are expected to give priority to the thinking processes involved and not to the outcome (in the mismatch condition) in order to evaluate the quality of thinking.

METHOD

Participants

A total of 116 children participated in the study from third ($n = 33$), fifth ($n = 35$), and seventh ($n = 48$) grades. The mean age of the third graders was 8 years and 7 months (range 8 – 9.5 years), of the fifth graders 10 years and 6 months (range 10.3 -11.4 years), and of the seventh graders 12 years and 11 months (range 12.5 - 13.6 years). They were students in two public primary schools and one secondary school located in urban and rural areas in North Greece and represented a variety of socioeconomic status backgrounds. Gender was equally represented in the sample ($n = 57$ girls and $n = 59$ boys) and in each group as well [$n_{girls} = 16$ and $n_{boys} = 17$ third graders; $n_{girls} = 17$ and $n_{boys} = 18$ fifth graders; and $n_{girls} = 24$ and $n_{boys} = 24$ seventh graders].

Measures and procedure

Children were examined individually in a private room in their schools and the examination lasted about 40-45 minutes. The participants were presented with 14 scenarios describing good and bad reasoning processes in everyday situations, such as deciding to buy a camera either by using an “eenie-meenie” strategy (bad version) or by writing a list with all the things one wants to have in one's camera (good version). The scenarios were originally constructed by Amsterlaw (2006), translated in Greek, and back-translated for the purposes of the present study.

At the beginning there were two *control scenarios* in which the bad and the good thinking processes were rather obvious. Control scenarios had a good and a bad version and they were used to verify that the children understood the task. In the good version an obviously good problem-solving strategy (such as listening to the teacher or trying) was followed by a student in order to solve a problem in a mathematics class. In the bad version, an obviously bad problem-solving strategy (such as not listening to the teacher or not trying) was followed by a student in order to solve the problem.

For the rest of the twelve scenarios, there were four different types (three scenarios in each type). There were: (a) *strategy scenarios* like the one given above; (b) *alternatives scenarios* in which someone either considers different alternatives (good version) to come to the conclusion (for example, about who stole his or her pencil), or jump to a conclusion without any consideration of the possible alternatives (bad version); (c) *pros-cons scenarios* in which the consideration of both the pros and the cons in order to make a decision (for example, take a pet in home) (good version) contrasted with deciding by considering only the pros (bad version); and (d) *evidence scenarios* in which an inference was made (for example, about what caused a drop in the growth of a plant) either by isolating variables and gathering all the related evidence (good version) or acting only intuitively (bad version).

Following Amsterlaw's design, the participants were assigned randomly to two conditions, a no outcome condition and a mismatch condition. In the *no outcome condition* there was no information given to the participants about the outcome of the reasoning process followed by the actor in each scenario. In the *mismatch condition*, at the end of each scenario, information was added about the outcome of the specific reasoning process but the outcome was in opposition with the reasoning process in the eight out of twelve scenarios (good processes paired with bad outcomes and bad processes paired with good outcomes). The rest four scenarios (one for each type) acted as filler scenarios, since in two of these, good processes were followed by good outcomes and in the final two scenarios, bad processes were followed by bad outcomes.

After reading each scenario, children were asked to rate on a four-point scale whether this way of thinking was very bad (0), bad (1), good (2), or very good (3). Also, they were asked to explain why they thought this (depending on the response in the rating scale). Their explanations were classified into categories according to the appropriate reference to the thinking processes involved in each scenario (for a detailed presentation of this procedure see Amsterlaw, 2006). In the *no outcome condition*, only responses that indicated the appropriate thinking process were considered as a sign of understanding.

For example, in the pros-cons scenarios, children had to infer that the actor "*thought not only the good but the bad things as well in making up his mind to buy the pet*" for the good scenario, and to infer that the actor "*thought only the good things in making up his mind to buy the pet*" for the bad scenario. All other answers were classified as wrong or irrelevant. The answers were coded by two of the authors independently and inter-rater agreement was 90%.

In the *mismatch condition*, explanations were coded into three categories according to their focus: on the outcome (for example, the girl liked the bicycle or didn't like it at the end); the thinking processes; and the outcome and the thinking processes (for example, she thought about the good things and the bad things and it turned out to be a good decision). A fourth category was added for irrelevant answers. Inter-rater agreement was 86% and disagreements were resolved through discussion.

RESULTS

We chose to analyze the data by focusing on the good and the bad aspects of thinking separately, irrespective of the type of scenario. This approach could give a more coherent picture of the developmental patterns about beliefs about the good and the bad properties of thinking. To summarize the data, the mean evaluation ratings of the four types of scenarios (strategy, alternative, pros-cons, and evidence) were combined separately for the good and the bad scenarios and for the two experimental conditions. These combinations resulted in two mean ratings for each condition. That is, there was one mean rating score for the good scenarios and one for the bad scenarios in the *no outcome condition* and one mean rating score for the good scenarios and one for the bad scenarios in the *mismatch condition*.

Effect of condition (no outcome vs mismatch) on evaluations of the thinking processes

All age groups in both conditions managed to distinguish the good from the bad thinking processes in the control scenarios. We decided, then, to skip these scenarios from the rest of the analyses.

At a first step we examined the effect of condition on participants' ratings in good vs bad scenarios. A condition (no outcome vs mismatch) x ratings (good vs bad) MANOVA was applied, with the ratings as a within-subject factor. The results showed that the main effect of the ratings factor was significant [$F(1, 114) = 135.18, p < .001, \eta^2 = .54$]. The mean ratings for good scenarios were significantly higher ($M = 2.04$) as compared to the mean ratings of bad scenarios ($M = 1.03$). Also, there was a significant interaction between the ratings and the condition factors [$F(1, 114) = 36.47, p < .001, \eta^2 = .24$]. The presence of a bad outcome in good version scenarios affected the participants' ratings more compared with a good outcome

in bad scenarios. A series of t-tests showed that the effect of the condition (no outcome or mismatch) was significant both for the good scenarios [$t(114) = 7.66, p < .001$] and for the bad scenarios [$t(114) = -2.234, p < .05$]. Good thinking scenarios were evaluated as significantly more good ($M = 2.42$) in the no outcome condition compared with the mismatch condition ($M = 1.65$), when they were followed by a bad outcome. Bad thinking scenarios were evaluated as more bad in the no outcome condition ($M = .90$) compared with the mismatch condition ($M = 1.17$) when they were followed by a good outcome. Finally, as expected, mean ratings of the four filler scenarios (each version matched with a compatible outcome) did not differ significantly in the two conditions [$t(114) = .930, p > .05$]. The respective means were: $M = 1.67$ for the no outcome condition and $M = 1.60$ for the mismatch condition. This shows the effect of the mismatch outcome in participants' evaluations. In the rest of the analyses we do not use the filler scenarios.

Age differences in evaluations of the thinking processes

In the next step, a MANOVA was applied in each condition (no-outcome and mismatch) separately, with the age as independent variable and the good and bad ratings as dependent variables. Means and standard deviations of the ratings are given in Table 1.

No outcome Condition. The effect of age was significant in the bad version ratings [$F(2, 56) = 6.47, p < .005, \eta^2 = .18$] and marginally significant in the good version ratings [$F(2, 56) = 3.22, p = .047, \eta^2 = .10$]. The application of Tukey multiple comparison tests showed that the difference was located only in the bad version ratings between the younger and the two older age groups (see Table 1). The younger age group (third graders) estimated as significantly less bad the bad thinking scenarios compared to the older groups (see also Figure 1).

Table 1: Means and Standard deviations of the participants' evaluations of thinking processes in Everyday Reasoning Scenarios by condition and age

Conditions	Version	Grade					
		Third grade		Fifth grade		Seventh grade	
		M	SD	M	SD	M	SD
No outcome	Ratings for Good processes	2.21	.47	2.50	.44	2.52	.37
	Ratings for Bad processes	1.29	.51	.61	.43	.83	.69
	Ratings for Good processes	1.59	.70	1.46	.61	1.82	.59
	Ratings for Bad processes	1.64	.41	1.25	.60	.79	.65

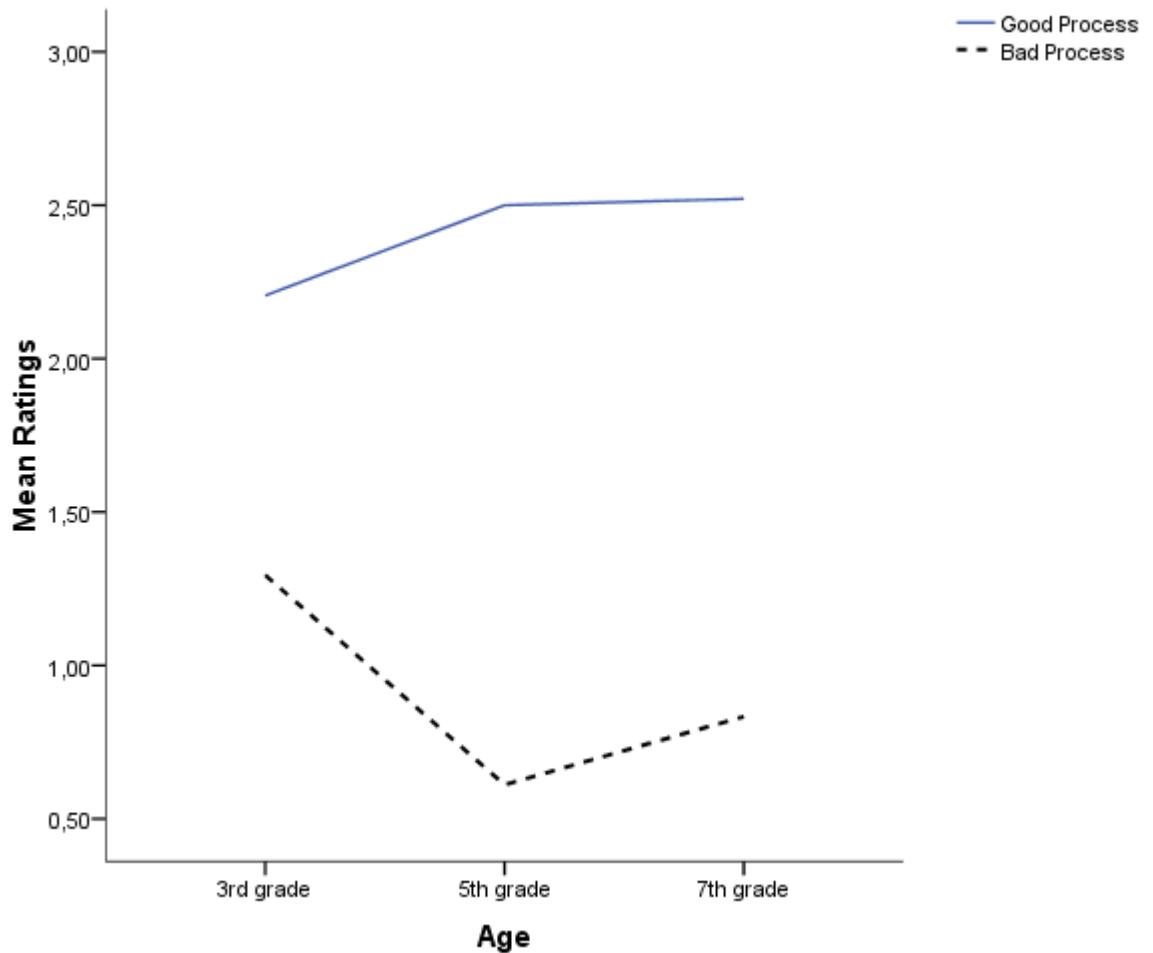


Figure1. Means of evaluations in the no outcome condition by age

Mismatch Condition. The effect of age was significant only in the bad version ratings [$F(2, 54) = 10.66, p < .001, \eta^2 = .28$]. The application of Tukey multiple comparison tests showed that the difference was located between the older and the two younger groups (see Figure 2). Seventh graders estimated as significantly more bad the bad way of thinking followed by a good outcome compared to the two younger groups (see Table 1).

Age differences in children's explanations

Children's explanations were analyzed for each type of scenario separately. The focus of the presentation again is on comparing explanations for good vs bad thinking processes.

No outcome condition. The application of χ^2 (chi square) showed no significant differences between ages in explanations in most of the good version scenarios (with the exception of the alternative scenarios). Specifically, the majority of children, irrespective of age, referred to the appropriate thinking processes in order to justify why they considered these scenarios as good. Only in the alternative good thinking scenario, significantly more third graders gave irrelevant explanations compared to seventh graders' process-focused explanations [$\chi^2(2, N = 59) = 14.43, p = .001$]. In the bad versions of these scenarios, however, significantly more third graders did not mention the non-appropriate thinking processes taking place in these scenarios compared to the seventh graders' explanations. The respective χ^2 values were: $\chi^2(2, N = 59) = 8.05, p < .05$ for the bad version of strategy scenario, $\chi^2(2, N = 59) = 10.31, p < .005$, for the bad version of pros-cons scenario, and $\chi^2(2, N = 59) = 13.68, p = .001$, for bad version of the evidence scenario.

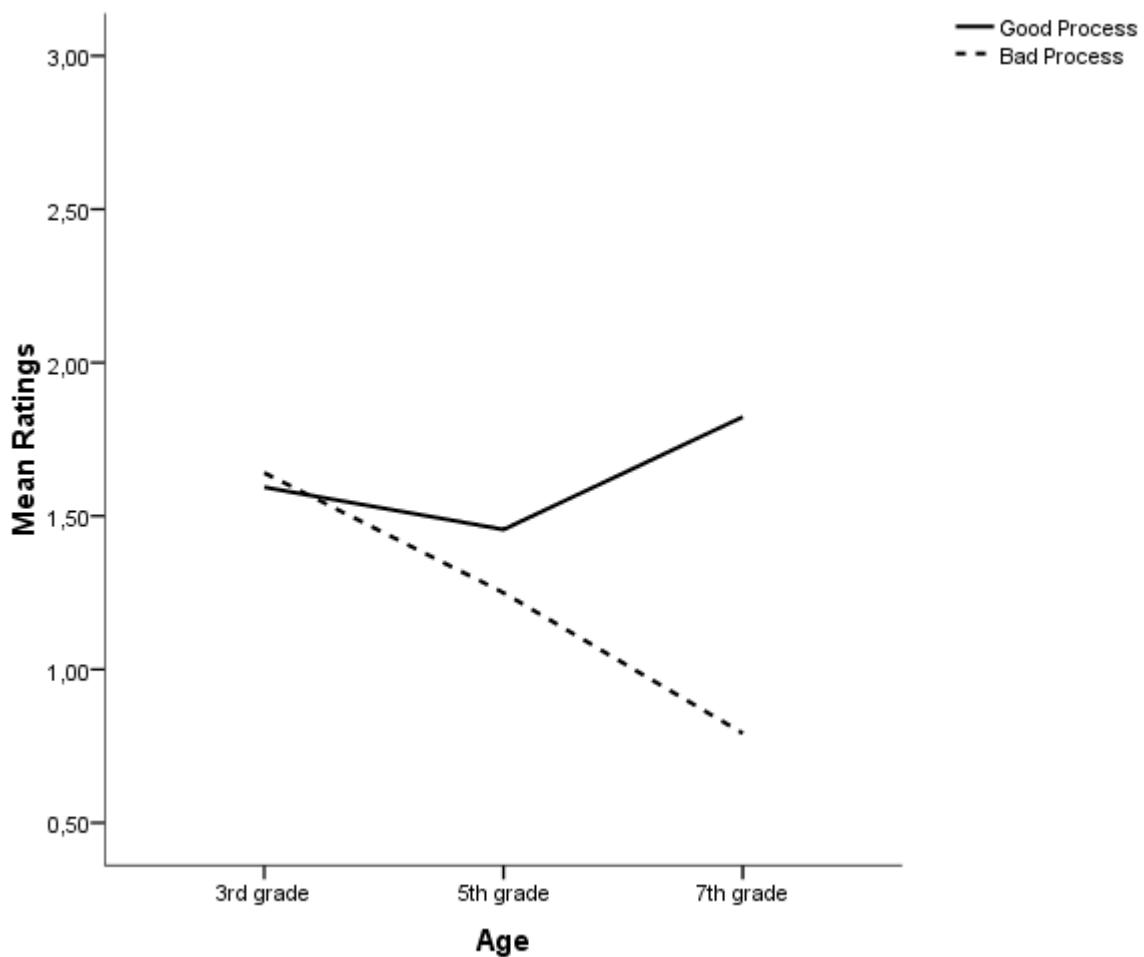


Figure 2. Means of evaluations in the mismatch condition by age

For example, in the most difficult case, the bad evidence scenario, almost all (16 out of 17) of the third graders did not mention the non-appropriate thinking processes in this scenario, while 15 out of 24 of the seventh graders, as well as half of the fifth graders, gave proper explanations by mentioning the bad way of thinking as a justification for having evaluated this thinking scenario as bad.

Mismatch condition. The confusing effect of the mismatch outcome was identified in the participants' explanations. In this condition, explanations were coded into four categories, one for the irrelevant answers and three according to their focus on the outcome, the thinking processes, or the outcome and the thinking processes, respectively. In the analyses we combined the last two categories (the thinking process-focused and the outcome and the thinking process-focused) because the focus in these explanations was on the thinking processes and not on the outcome. Also, the first two (irrelevant and outcome focused) were combined to one category. There were, then, two categories, one for the process-focused explanations and one for all the other answers.

The value of χ^2 was significant only in two cases. It was marginally significant in the bad alternative scenario [$\chi^2(2, N = 57) = 5.81, p = .055$], where half of the third and fifth graders gave non process-focused explanations, while only five out of 24 of the seventh graders did the same. Also, in the bad evidence scenario [$\chi^2(2, N = 57) = 8.13, p < .05$], almost all of the third graders (15 out of 16) reported irrelevant or focused on the outcome justifications, that is, they judged a bad way of thinking as good on the basis of the outcome. Only about half of the fifth and seventh graders did the same.

DISCUSSION

The aim of the study was to provide evidence for the development of reasoning beliefs in “good” and “bad” thinking processes in everyday situations. A Greek sample of children was examined using Amsterlaw's (2006) experimental design. Children as young as third graders were expected to exhibit a well-developed ability to distinguish between “good” and “bad” thinking processes (Hypothesis 1). The results of the present study confirmed Amsterlaw's findings. Third graders significantly differentiated between good and bad thinking processes in the no outcome condition (see Figure 1). An interaction effect was found, however, between the thinking processes (good vs bad) and age in the bad thinking scenarios. The fifth and seventh graders estimated as significantly more bad the bad thinking scenarios compared to the third graders.

In the mismatch condition, however, the incompatible outcome confused even the older children. Mean ratings for good processes in this condition were significantly lower compared to the mean ratings in the no-outcome condition in all age groups. A good way of thinking matched with a bad outcome caused a drop in mean ratings about 0.78. The same was evidenced in Amsterlaw's study. She found a drop of about 0.63 even in adults' mean ratings. The seventh graders, however, reacted differently from the two younger groups in the bad version scenarios. A bad thinking process followed by a good outcome affected only the third and fifth graders' ratings.

It is noteworthy that only the seventh graders' evaluations did not differ significantly in both conditions (no outcome and mismatch), while the third graders evaluated the bad processes as more good even from the good processes in the mismatch condition (see Figure 2). Taking into consideration the mean level differences as well as the large effect size of age (0.28), the results of the present study showed a clear advantage of the seventh graders in their ability to evaluate the quality of the thinking processes in everyday scenarios, without having the outcome as the primary basis for their evaluations, but only where bad thinking processes are involved.

According to Amsterlaw (2006), one reason for outcome biases in children's evaluations is that they lack the metacognitive knowledge necessary for making process-based judgments. Evaluating a way of thinking as good or bad presupposes a well-developed metacognitive knowledge base about the properties of thinking as a cognitive function and as a process. In the present study, children as young as 8 or 9 years old discriminated the good from the bad way of thinking but the quality of thinking as a process was still bounded up with its outcome. These results confirm Amsterlaw's results in a different culture, implying the existence of a general pattern in the emergent ability to evaluate the quality of thinking as an inferential process in everyday situations.

Moreover, the present results indicate an emergent ability in fifth graders to give more precise evaluations and more process-focused explanations for the bad thinking processes as compared to the third graders, mainly in the no-outcome condition. However, the results suggest a developmental change in the seventh grade, which is restricted however to the bad thinking processes. Only the seventh graders presented an adult-like pattern by giving priority to the thinking processes involved and not to the outcome in order to estimate the quality of thinking. The above results only partly confirmed Amsterlaw's evidence for a clear adult-like pattern of process-focused explanations in fifth graders though there is an emerging ability in understanding bad thinking processes. The results of the present study could reflect differences in the classification of the participants' explanations by the authors or differences in the combinations of explanations used as dependent variables. Future research with a more diverse sample of participants and tasks could shed more light on the developmental trend.

Also, the present results stress the role of experience in the development of awareness about thinking in everyday reasoning. Personal experience with various everyday reasoning scenarios and social learning extend older children's metacognitive knowledge base, leading to more process based estimations. However, the development of metacognitive knowledge about informal reasoning is not linear, not accurate, and not free of bias. Good thinking

processes which are followed by a bad outcome were found to confuse seventh graders and even to confuse adults in Amsterlaw's study.

It seems that a bad outcome represents a non smart response to a problem and, consequently, the thinking process which leads to such an outcome is considered to be a lesser level of reasoned thinking (see also Heyman, Gee, & Giles, 2003). Doubts or second thoughts are activated about the quality of the way of thinking. We need, then, to have in our metacognitive knowledge base not only information about thinking as a process but also information about the internal or external causes of good and bad outcomes. Given that children are able to understand the effect of effort, ability, task difficulty, and luck on their success or failure in achievement settings by twelve years of age, future research could examine the role of children's causal attribution schema on their ability to dissociate the quality of the thinking process from its outcome.

In general, our knowledge about children's conceptualization of thinking as a reasoning process in everyday contexts is too limited and future research should shed more light on to the role of metacognition on the development of thinking skills. Could developmental changes in metacognitive knowledge about thinking as an inferential process lead to developmental changes in reasoning ability (see Moshman, 2004)? Moreover, is an awareness of thinking as an inferential process in one aspect of reasoning facilitated by the development of awareness in other aspects of reasoning or are these changes imposed by broader metacognitive changes in awareness of the constructive processing aspects of mental activities in middle childhood (see Schwanenflugel et al., 1998)? These are promising areas for future research. Only a combination of longitudinal and cross-sectional designs could answer these questions.

The specific characteristics of the sample as well as the structural characteristics of the tasks used in the study limit generalization of the findings. Despite these limitations, the present data confirmed in a different culture the argument that children as young as eight to nine years of age have a well-developed awareness of good and bad thinking processes in everyday situations. Also, the present results demonstrate an increasingly explicit understanding of thinking as a mental process segregated from its outcome as age increases. They indicate, though, that the pattern of development is affected by our tendency to value thinking because it is a safe way of reaching a solution or making the right decision. More research, especially longitudinal research, is needed to shed light on critical periods in this developmental pattern.

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